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DEVELOPMENT OF IMAGE RECONSTRUCTION USING COMPUTED TOMOGRAPHY

RITESH PRAFULLA VEDAK, SANDESH P. MHATRE, AKSHAY V. GORE & NISHANT B. PATIL

Department of Biomedical, MGM College of Engineering and Technology,

Mumbai University, Kamothe, Navi Mumbai

ABSTRACT

The objective of this article is to understand the application of computing tomography scan in medicine, non-destructive testing/evaluation and to analyze the functioning of the internal body structures.

***KEYWORDS**: Development, Tomography, CT Scan & MATLAB*

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Original Article

INTRODUCTION

Developed in the early 1970s, CT scans revolutionized medical radiology, enabling physicians to obtain the high-quality tomographic images to study the functioning of patients' internal structures. The CT scan can reconstruct and detect the internal structure by transmission of source of a large number of multiple projections of an object.

The CT scanned images obtained are of three formats, namely, TIFF, JPEG and DICOM; DICOM images being more effective compared to others. Based on this concept, DICOM image format was used as the input for MATLAB programming of reconstruction techniques. In the latest version, the X-ray tube and the detectors of the CT scanner are mounted on a ring-shaped gantry that rotates around the patient being scanned, which also enables helical scanning.

Various medical applications such as neurology, oncology, and cardiology, CT scan is of great help.

RECONSTRUCTION TECHNIQUES

Back Projection

As the name suggests, in back projection method, the ray projects back an equal amount of rays, furthering the estimated image, and this is applicable at all angles and for all projection points. Being the oldest technique, it is not used in the modern CT scanners.

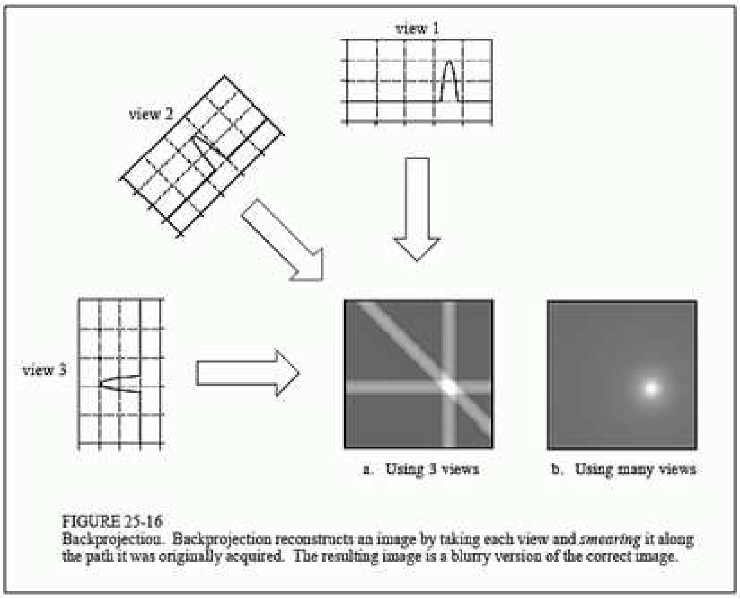

FIGURE 25-16
Backprojection. Backprojection reconstructs an image by taking each view and *smearing* it along the path it was originally acquired. The resulting image is a blurry version of the correct image.

Figure 1: Back Projection

Filter Back Projection

The image blurring issue in the simple back projection is corrected using filtered back projection. To create a set of filtered views, the dimensional views are involved with another dimensional filter kernel. To provide the reconstructed image, which is a near comparative of correct image, the filtered views are back projected.

Among a large number of projections extensively used in imaging, filtered back projection method outshines with regard to speed and accuracy, with direct inversion of the projection formula. For filter back projection, homomorphic filter is used to enhance, remove multiplicative noises and simultaneously normalize the image's brightness and contrast.

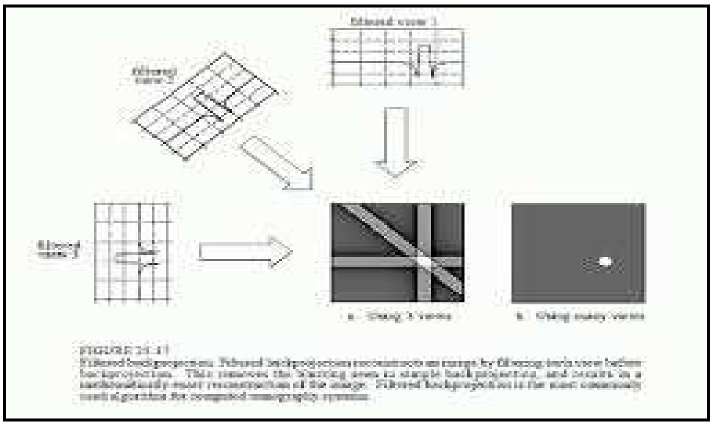

Figure 2: Filter Back Projection

Iterative Reconstruction

In iterative reconstruction, a type of imaging technique, 2D and 3D images are reconstructed using iterative algorithms, that is, by projecting an object the CT images are reconstructed. Iterative reconstruction techniques are generally considered more expensive than the common filter back projection method, though it is assumed upgraded. According to various researches, iterative reconstruction can support extremely fast computations and massive parallelism,

enabling its practical commercialization.

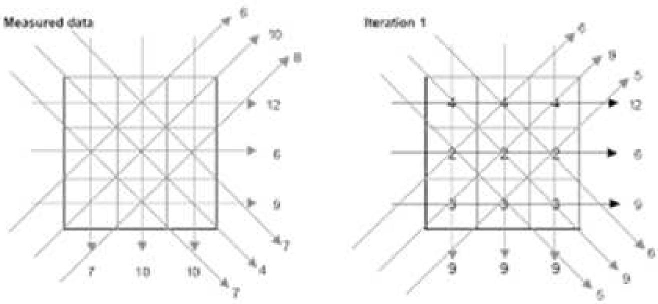

Figure 3: Iterative Reconstruction

Fourier Reconstruction

Fourier reconstruction is a method that defeats the calculations of the iterative method of image reconstruction. Because of the calculations involved, the iterative method is looked at as time-consuming and tiresome. On the other hand, the drawbacks of back projection are severe blurring of the computed images. Fourier transform is defined as:

$$\hat{f}(\xi) = \int_{-\infty}^{\infty} f(x)\, e^{-2\pi i x \xi}\, dx,$$

Converting a capacity from the time (or spatial) domain to the frequency domain.

Where:

- The independent variable *x* represents *time* (with SI unit of seconds),
- The transform variable ξ represents frequency (in hertz).
- F(x) should be continuous and integral.
- 2-dimensional images are defined,
- The 2D Fourier transform of the function *f* (x, y) is given by:

$$F(u,v) = \int\int_{-\infty}^{\infty} f(x,y) e^{-j2\pi(ux+vy)} dx\, dy$$

- In practice, we often deal with discrete functions.
- For a square image of size N×N, the two-dimensional DFT is given by:

$$F(k,l) = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} f(i,j)\, e^{-\iota 2\pi(\frac{ki}{N}+\frac{lj}{N})}$$

SOFTWARE DETAILS

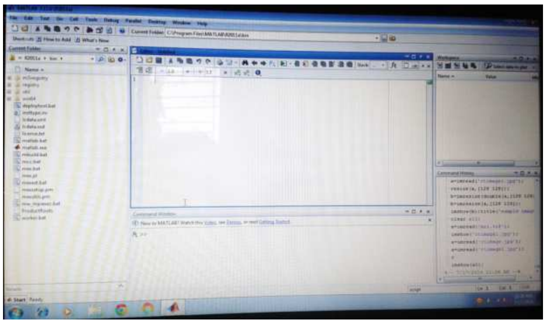

Figure 4: MATLAB Screen

The world's most natural way to express computational mathematics is achieved by a matrix-based language MATLAB, which is used to analyze and design the products. This is used to resolve all engineering and scientific issues and allows to take ideas out of the desktop. Using built in graphics, MATLAB permits simple visualization, augmenting data perceptions. With essential algorithms of one’s domain and a vast library of prebuilt toolboxes, one can start the scan process. Integration of MATLAB code with other languages enables one to use algorithms and applications within web enterprise and production systems.

MATLAB in Biomedical Field

Certain dreadful diseases such as cancer, thyroid, various blood-related diseases, etc. are threatening the humankind. An exigency vigilant is attained by deploying biomedical applications. The diversity of MATLAB has been of great help in many major fields such as:

- Biosignals and biomedical imaging
- Applications in biomechanics and nanobiotechnology
- Cell- and tissue-based micro applications
- Simulation and modelling of biomedical system
- Biomedical imaging, sensing and genomic signal processing applications
- Clinical engineering
- Medical imaging and physical modelling
- Medical and healthcare technology
- Data mining concepts in biomedical imaging

CONCLUSIONS

With the help of projected data and through various reconstruction algorithms as back projection and filter back projection techniques images can be reconstructed. Assimilating the functions of different reconstruction techniques, it can be concluded that filter back projection technique is better than the back projection technique.

The assets of the iterative methodology are improved insensitivity to noise and ability to reconstruct optimal images in instances of incomplete data. This strategy is presumed lofty, especially in the absence of a large set of projections, during the unequal distribution of projections in the angle, or during sparse or missing projections at certain orientations. These scenarios are likely in intra-operative CT, in cardiac CT, or when metal artifacts demand the exclusion of certain projection portions.